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COMPRESSIVE STRENGTH OF GREEN CONCRETE FOR THE SUSTAINABLE DEVELOPMENT OF CHHATTISGARH, CENTRAL INDIA

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ABSTRACT

This paper mainly focusing on the compressive strength and durability of bricks fabricated by the use of fly ash and polypropylene fiber from the site of national thermal power corporation korba, and bhilai chhattisgarh, central india as a partial replacement of 25%, 55% and 100% of sand due to high price as per the instruction of chhattisgarh states mineral policy act and rules 2013 which is being used for construction work. An experimental investigation has been carried out to find out the compressive strength of eco-friendly green concrete with different curing methods. Polypropylene fiber was used to increase the compressive strength of concrete. Totally 09 cubes were cast and tested. Based on the experimental results, mechanical strength studies, and a two length of 06 mm and 10 mm and three volume fractions 1.0%, 2.0% and 3.0% are chosen for further studies. An equation recommended by ACI committee for conventional concrete was used to predict 7, 28, 56, 90 and 180 days compressive strength from 28 days compressive strength of the eco-friendly green concrete. This testing was concluded that the later age compressive strength will save finance, time and material.

KEYWORDS: Compressive Strength, Green Concrete, Fly Ash, Polypropylene and Curing

INTRODUCTION

Green concrete has nothing to do with color. It is a concept of thinking environment into concrete considering every aspect from raw materials manufacture over mixture design to structural design, construction, and service life. Green concrete is very often and also cheap to produce, because, for example, waste products are used as a partial substitute for cement, charges for the disposal of waste are avoided. Waste can be used to produce new products or can be used as admixture so that natural sources are used more efficient and the environment is protected from waste deposits [1-2].

Fly ash is an artificial pozzolans, when mixed with lime ie. calcium hydroxide to form cementitious compounds. Concrete containing fly ash becomes stronger, more durable, and more resistant to chemical attack. In the construction sector, the fly ash is used in the production of cement as an additive-material, in production of concrete instead of some of the cement or instead of some of the fine aggregate, as a base and sub-base material in highway construction, as a filling material in dams in retaining walls, and for production of light construction materials [3-5]. T.C. Hansen and S.E. Hedegaard [6] reported in the paper “Modified rule of constant water content for constant consistency of fresh fly ash

concrete mixes" that there exists an upper limit to sum of fly ash and portland cement, beyond which it is not possible to compact to maximum density. Using the fly ash in the concrete generally increases the workability of the fresh concrete, decreases the bleeding, decreases the hydration temperature, decreases the permeability of the hardened concrete, increases resistance of the concrete to the chemical effects, and decreases the costs[7-11]. Recently in a chhattisgarh state rivers sand is widely used in fine aggregate constitutes near about 40% in concrete. Near about 12 billion tons of concrete is used every year in the world[12]. The use of river sand must be minimized due to scarcity and high cost and search an alternate material which possesses the properties of sand should be explored through the research. This will result in the sustainability and can prevent the depletion of river sand which will result in the environmental problems such as loss of estuaries, loss of ground water, soil erosion in river bed and other associated problems[13-15]. Fly ash a high performance green concrete shown in figure-1.

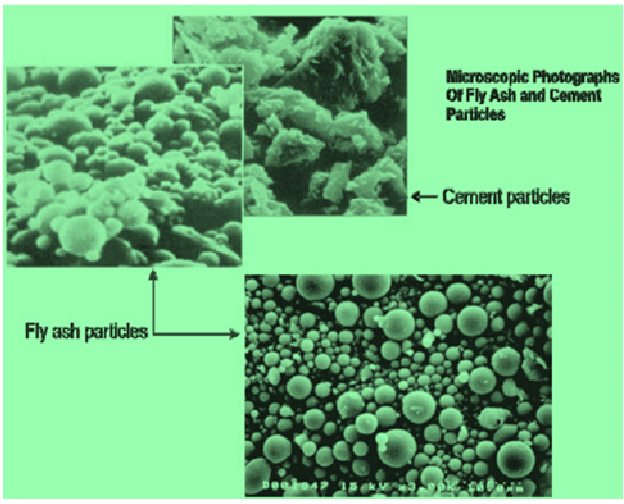

Figure 1: Fly Ash a High Performance Green Concrete

In nominal lengths of 6, 8 or 10 mm, polypropylene reduce plastic shrinkage, cracking and crazing and improve the surface properties of the concrete. When fibers are used, it is very often possible to replace meshes by the fiber. To achieve the phase mechanical strength tests on standard specimens such as compressive strength were conducted on the fibrous concrete specimens to obtain the optimum volume fraction and length of fibers.

OBJECTIVES OF THE STUDY

To test the mechanical compressive strength of green concrete for the sustainable development of rural areas of chhattisgarh, India.

Need Behind My Goal?

This study is to bring an acute sustainable development among the people of rural areas due to high price of river sand in chhattisagrh, green concrete, recycle of fly ash and polypropylene were used for innovative analysis.

What You Want to Solve?

After publishing of this research article, we want to develop the awareness due to low cost of materials among the people and government for the need of green concrete to sustainable development of chhattisagrh.

STUDY AREA

ArcGIS (version 9.0) software has been used for the present study to locate the sampling sites. India is situated in the latitude of 22° 00' N and longitudes of 77° 00’ E denote its geographical alignment. The specific latitude of India suggests its position in Northern Hemisphere. The terra firma of India is bounded by the Bay of Bengal, Arabian Sea, Pakistan, Bangladesh, Myanmar, Nepal, Bhutan and China. The current study area of Chhattisgarh state, Central India, situated in Latitude: 21° 27' N and Longitude : 81.6° 0' E (figure: 2), It is the 10th largest state in India, with an area of 135,190 km², with a population of 25.5 million, chhattisgarh is the 16th most-populated state of the nation.

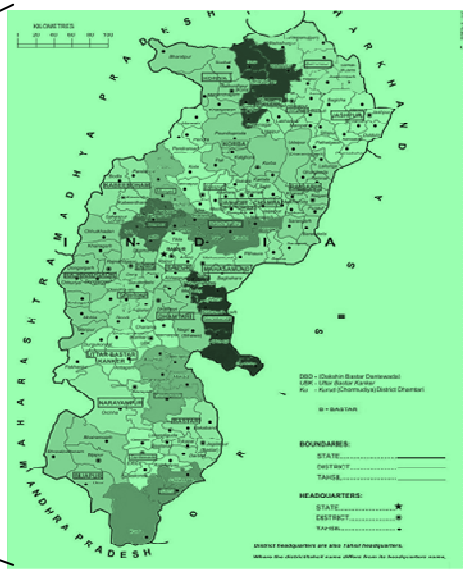

Figure 2a: Locations of Chhattisgarh in India **Figure 2b: Different District Locations in Chhattisgarh**

MATERIAL AND METHODS

Mix Proportions: Cement used was ASTM C150 (2011) type I ordinary Portland cement of 53 grade. Natural siliceous river sand, which was locally available for construction activities. Coarse aggregate used was crushed granite stone with the size ranging between 12.5mm and 20mm. Water used for mixing and curing of concrete was ordinary potable water and mixture which is light brown in colour with the pH of six[14].

Compressive Strength Studies: The compressive strength of normal, mixture of fly ash and polypropylene containing soil on dry, casted and was tested using compression testing machine shown in figure 3. Table 3 summaries the strength characteristics of the Polypropylene fiber, fly ash and soil. Polypropylene fiber soil block without addition of fibers has the lowest compressive strength of 13.45 MPa as compared with those with fiber addition. According to Indian Standard specifications (IS: 516– 1959), the compression test on cubes was conducted. To evaluate the mechanical strength characteristics of concrete reinforced with polypropylene fiber, detailed experimental investigation was carried out and the results are discussed. Totally 10 cube specimens of size 150× 150× 150 mm with 3 mixes were casted and tested. Three volume fractions were considered for of two different lengths. Results for compressive strength based on the average values of three test data. In the case of fiber enhanced soil block, the compressive strength increased with increase in weight fraction of fiber content, for both types of fiber, as shown in Figures 3.

Figure 3: Experimental Work in Material Testing Lab of a High Performance Green Concrete

RESULTS AND DISCUSSIONS

On the analytical results so obtained for different study parameters from different sampling locations in different seasons of the year 2014 are summarized below in Table 1. Here the properties of polypropylene fiber was found mentioned in the table 2.

Table 1: Technical Specification of Fly Ash Used

Constitution of Compounds	IS 3812: 2003 Part 1 in%	BS EN 450 Category N in%	Percentage of Amount
Loss on Ignition (LOI)	1.5-5.0	1.0-5.0	2.31
Moisture	2.0	2.0	0.8
SO_3	3.0	3.0	1.47
CaO	-	2.5 max	18.67
MgO	5.0	4.0 max	1.54
SiO_2	35 min	-	45.98
Al_2O_3	-	-	23.55
Fe_2O_3	-	-	4.91
TiO_2	-	-	0.04
Na_2O	1.5 max	5.0 max	0.24
P_2O_5	-	100	0.20
Fineness (retention on 45 micron sieve)	34 max	40 max	18-20
Particle Density	-	-	2200-2300kg/m^3

Table 2: Properties of Polypropylene Fiber[13]

Materials	Polypropylene
Fiber cut length	6mm,10mm
Sp. gravity	0.914
Bulk density	910Kg/m^3
Tensile strength	0.671KN/mm^2
Absorption	NIL
Melting point	>164^{0}C
Young Modulus	4.0 KN/mm^2

Table 3: Compressive Strength of Mixture Cubes

Samples	Max. Compressive Strength (MPa)
S_{x1}	12.00
S_{x2}	12.29
S_{x3}	13.40
S_{y1}	13.45

Table 3: Contd.,	
S_{y2}	14.32
S_{y3}	14.87
S_{z1}	16.90
Sz_2	17.11
S_{z3}	17.65

Where S_{x1-x3}= Plain cement concrete, S_{y1-y3}= Concrete with fly ash S_{z1-z3}= Concrete with1%,2%,3% Polypropylene fiber of 6mm or 10mm cut length.

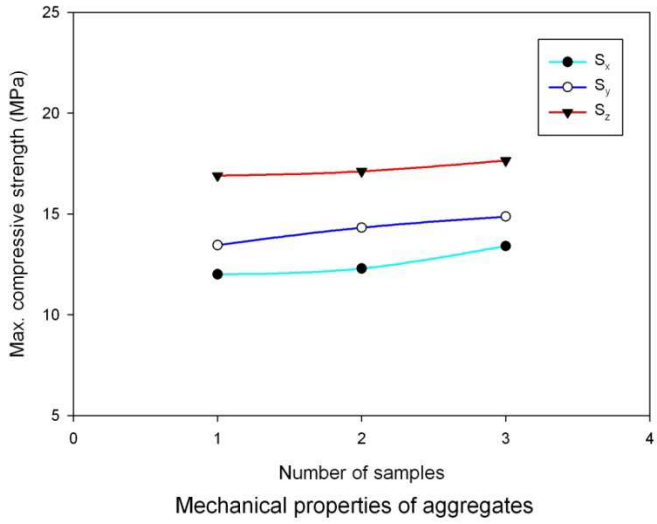

Figure 4: Plot of Graph between Number of Sample vs Maximum Compressive Strength

A fly ash concrete mix, designed for equivalent performance to conventional concrete at normal ages, will generally gain strength more slowly at early ages. After about seven days, the rate of strength gain of fly ash concrete exceeds that of conventional concrete, enabling equivalence at the desired age. This higher rate of strength gain continues over time, enabling fly ash concrete to produce significantly higher ultimate strength than can be achieved with conventional concrete.

Table 4: Experimental Analysis of Age (Days) and Comparative Strengths in N/mm^2

MIX	7 Days in N/mm^2	28 Days in N/mm^2	56 Days in N/mm^2	90 Days in N/mm^2	180 Days in N/mm^2
MIX A (Plain Concrete)	19.25	34.31	45.23	54.91	59.10
MIX B (Fly Ash Concrete)	19.23	39.21	54.23	64.80	75.73
MIX C (PP+Fly ash Concrete)	19.27	44.58	63.61	75.63	86.31

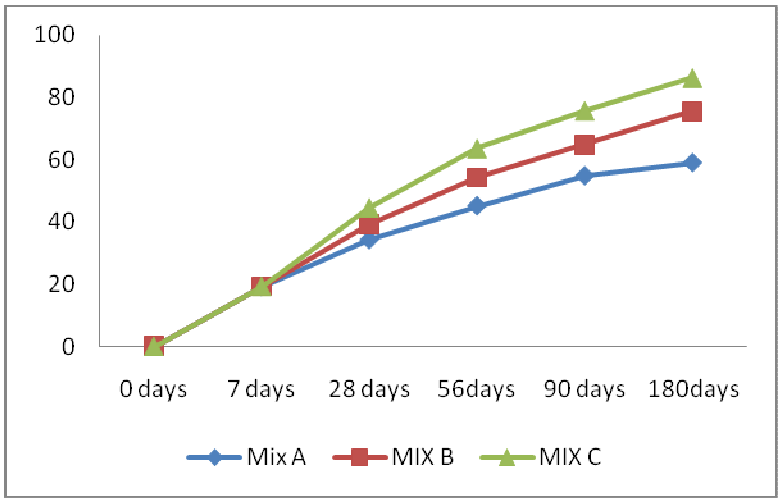

Figure 5: Plot of Graph between Compressive Strength vs Number of Days

On the plotting of the graph between compressive Vs number of days, graph shows the on increasing the number of days compressive strength should be increases.

Fly ash concrete designed for equivalent performance at seven days or earlier will yield practically the same strength gain prior to the design age. At all ages thereafter, fly ash concrete will exhibit much higher strength gain than conventional concrete.

Advantages of Green Concrete: The main applications and advantages of fiber reinforced concrete can be used in all types of concrete to achieve enhanced quality concrete with any finish. Main uses are: In a Drive ways, Pathways, Floors (industrial, commercial or domestic), Cold Room floors and very thin sections with large surface to thickness ratios. Homogeneous reinforcing, reducing the possibility of spalling at concrete edges, Simplifies construction process, Precise placement of steel mesh is not required, Reduces labour required to place and handle mesh, Easier construction method and only one concrete application saving time, Improves the wet mix by reducing the potential of concrete segregation, Reduces the overall bleed and consequential settlement cracking, Inhibits early plastic shrinkage cracking, Increases the cohesiveness of the concrete, Removes the potential risk of corrosion of steel crack control mesh and Cost effective versus steel mesh.

CONCLUSIONS

This experimental investigation revealed the potential utilization of bottom ash as fine aggregate that can promote it as eco-friendly green concrete since the use of natural river sand is minimized. From the results, it is concluded that 30 % of fly ash and polypropelene mixture can be used as river sand in concrete without affecting the compressive strength of the concrete. Polypropylene fiber of 6 mm cut length inclusions in amount of 1.0%, and 2% increase the compressive strength up to approx. 35% to 55% respectively. Our result shows that 1.0% inclusion of polypropylene fiber give less strength than 3% of polypropylene fiber. For special structures like dams and ports, replacement levels can be up to 70%. Addition of fly ash improves workability, and it is recommended that volume of water is reduced by 2.5% for every 10% of fly ash used. Quantity of sand can be reduced by 0.5% for every 10% of fly ash used. The importance of curing method for quality assessment and predicting later age compressive strength is highlighted regardless of the material used in the concrete that will help the designer to improve the design of construction. The empirical relationship predicts the 28, 56, 90

and 180 days compressive strength just after 28 hours from the accelerated cured compressive strength with the maximum error of 5%. This ultimately saves the time, material and also enhances rapid and quick quality assessment in the construction.

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